

Employment effects of an increase in sugar tax

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Abstract

This paper examined the changes in employment in industries with close ties to sugary products sales following an increase in sugar tax in Norway in January 2018. Using the data from Statistics Norway and having removed seasonality, interrupted time series analysis was conducted. Data on food manufacture, beverage manufacture as well as wholesale and retail trade excluding motor vehicles and motorcycles was studied. Additional analysis was conducted for robustness specifications. The paper discovered a small and negative, statistically significant intercept change in employment in wholesale trade sector. This could be indicating some short-term effects of the increased sugar tax. Evidence from beverages manufacturing sector show a significant and positive post-tax trend change. This could indicate some long-term effects. Wholesale trade sector experienced a decrease in the number of people employed. The beverages sector witnessed an increase in the employment level after the tax was increased. No other significant effects were discovered with the available data. Robustness tests failed to confirm the validity of the results. Warranting with respect to the outcomes must be taken. It is unlikely that the employment changes found in the paper were caused by an increased sugar tax.

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1 Introduction

This section offers an overview of the topic and states the scope of the study.

Most of the countries strive to obtain high employment and attempt to achieve this goal by the means of fiscal or monetary policy. Usually, expansive fiscal policy is orchestrated by a government to decrease unemployment (Tragakes, 2011). This implies eliminating or decreasing taxes and increasing government spending. An example of expansive fiscal policy aiming at higher employment is decreasing sales taxes such as taxes on sugar. Alongside having employment goals, a large number of countries also have well-being goals and attempt to limit the consumption of demerit goods in favour of its citizens. Sugary products have long been known to cause long- and short-term damage to its consumers (Brownell et al., 2009; Escobar et al., 2013; Ludwig et al., 2001; Thow et al., 2014; World Health Organization, 2017). Levying additional health taxes on sugar or sugar-rich products is designed to boost the well-being of citizens. There is some evidence of that sugar taxes are successful in decreasing consumption of sugary products (Escobar et al., 2013; Thow et al., 2014), but these health taxation schemes have often been accused of threatening domestic producers, harming the poorest consumers and increasing general unemployment (NTB, 2018). This leads to a trade-off policymakers face between pursuing higher employment levels or improved well-being of the society. During the last decade, France, Finland, Hungary, Great Britain, Mexico and several states of the USA decided to focus on the well-being of the society and introduced some form of a sugar tax (Wright et al., 2017). Norway specifically increased the already high sugar tax in January 2018 (Finansdepartementet, 2017).

The issue of sugar taxation has been addressed relatively early in Norway compared to other European countries. A sugar tax was first introduced in 1922 and was designed to primarily generate revenue to the government. In recent decades, the aim of sugar taxation has been attributed to a nation-wide health-promoting package by the means of which the Norwegian government attempts to reduce the consumption of sugary products, especially soft drinks and chocolate confectionery (Nieburg, 2018; Tisdall, 2007). The economic rationale behind the Norwegian sugar tax is to discourage consumption of potentially harmful sugary products and to raise revenue to compensate for the incorrectly signalled costs to the society. An *excise tax* is a type of selective sales tax levied on certain kind of consumption activity (Rosen, 2004). Because sugar as an input is too cheap, the price of sugary products is too low from the societal perspective. To raise the price and equate social and private costs, Pigou (2017) designed a kind of excise tax called *pigouvian tax*. By taxing sugar, the quantity demanded of sugary products should decrease. The decline in quantity demanded of the sugar products can induce a lower production level which translates into a decrease in employment in that part of the

economy. This can cause a general rise in unemployment if old employees don't find new jobs or leave the labour market (Hyman, 2011; Rosen, 2004).

Sugar taxes, as an example of externality taxation, have primarily been studied within the fields of medicine and health economics. Distribution effects, as well as wellness outcomes connected with sugar taxes, have been given some attention but fewer studies have been conducted on the employment effects of such a tax. Moreover, the existing studies considered almost exclusively Mexico and the USA. Thus, the majority of macroeconomic notions connected with the European health taxes haven't been thoroughly studied. The aim of this paper is to explore the economic trade-off between high employment and well-being of the society by answering the following research question:

Is there a significant change in employment in selected industries following an increase in sugar tax in January 2018?

By looking at the employment change following a higher tax on sugar in industries with close ties to sugar and sugary products sales, the causality between unemployment and health taxes will be examined. In order to achieve this, employment in food and beverage manufacturing sectors, wholesale and retail trade without motor vehicles and motorcycles will be analysed using interrupted time series analysis (ITSA). This paper is going to add to the extensive research focused on the cost-benefit analysis of sugar taxes by specifically addressing the employment effect of the increased sugar tax in Norway.

This paper is structured as follows: section 2 explains the theory behind the economics of the issue of sugar tax in Norway and the existing literature on the subject. Section 3 accounts for the data collection strategy. In section 4 applied empirical estimation is presented and in section 5 the results of the paper are summarised. The robustness tests and validity can be found in section 6. The discussion of ITSA results is located in section 7. Number 8, the last section, concludes the paper and suggests future research.

2 Background

In this section an overview of relevant literature and theoretical framework are being presented.

2.1 Theoretical framework

After January 2018 a 37.32 Norwegian crowns (NEK) per kg tax was levied on sugary products, see Figure 1. The economic model of demand and supply predicts that on a competitive market increasing the price of a product, by subjecting it to a tax, will lead to a decrease in the quantity demanded of that product, ceteris paribus. On the Norwegian market, a supply shock caused by the increase in sugary products prices due to a higher tax will move the supply curve upwards. Subsequently, higher consumer prices will discourage consumption of the now more expensive sugar or sugary products. The consumers might switch to imports or substitutes as long as these are cheaper (Tragakes, 2011). On the assumption that sugary products and sugar are responsive to changes in prices, consumers will react to a higher tax and by a chain reaction narrow the employment possibilities available in the industries producing mainly the sugary products (Rosen, 2004).

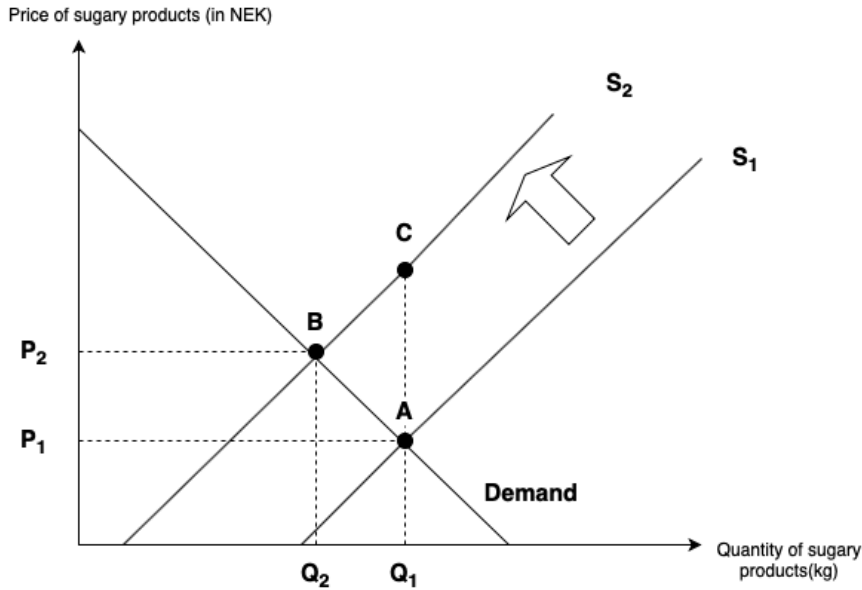


Figure 1: Visual depiction of the effect of an increased sugar tax on the Norwegian sugary products market, demand remaining unchanged.

The situation is illustrated in Figure 1. The initial equilibrium is depicted at letter **A** where the price is P_1 and quantity Q_1 . When the new taxation scheme becomes enacted, production costs become higher. The supply curve shifts to the left from S_1 to S_2 and the average sugary product prices increase to P_2 , causing lower quantity demanded Q_2 . Vertical distance **AC** shows the new tax. A post-tax optimum lies at a higher price and

lower quantity demanded depicted by letter **B**. With the demand remaining unchanged, the shift in supply stimulates less domestic production. Hu (2002) explains that under plausible assumptions, a decrease in quantity demanded translates in large part into a decrease in production. Norwegian firms specialising in providing sugary products would lay off workers, contributing to lower employment.

2.2 Literature

Studies such as the paper published by Neslin and Shoemaker (1983) confirm that sugary products are normal goods and that their demand should respond to changes in price, even if manufactured sugar products are more responsive to changes in prices than sugar as a raw commodity is (Tragakes, 2011). Using a Quadratic Almost Ideal Demand System model or QUAIDS ¹ Guerrero-López et al. (2017b) estimated price elasticity of sugary drinks to be about -1.37 and sweet snacks to be around -1.21, using data on consumption from surveys conducted in Chile. Another study performed using a Linear Approximation of Almost Ideal Demand Systems, or LA/AIDS ² in Mexico found similar results, estimating own price elasticity to be -1.06 and -0.97 for sugary drinks and sweet snacks respectively (Colchero et al., 2015). These empirical results are consistent with the economic reasoning behind Figure 1 and indicate that the domestic market for sugary products in Norway should react in a predictable way, subsequently causing some increase in unemployment.

A serious concern about the employment consequences of increasing sales taxes in Norway was summarised in a general form by Hyman (2011) in the following statement:

”A possible effect of local sales taxation is a loss of retail trade to neighbouring jurisdictions where the sales tax is either absent or applied at a lower rate. The migration of retail sales to another taxing jurisdiction can have the effect of reducing employment, business profits in the taxing jurisdiction, or both.”

Health taxation, like any other taxation, can be a source of economic tradeoffs. Hyman (2011) points out that taxing a product might lead to a local decrease in sales and subsequent unemployment. On the foreign market, the price of sugary products will be relatively lower than the Norwegian prices and can lead to a migration of retail sales to foreign tax jurisdictions. Just as Hyman (2011) reasons, Sweden, which didn’t implement any sugar tax, attracted Norwegian customers who were willing to buy cheaper sugary foods. This was experienced by a number of Swedish and Norwegian business owners located near the border between the two countries, both of whom noticed an increase in

¹Almost Ideal Demand Systems approximates consumer demand systems that are non-linear. The model is based on cost/expenditure function and in this case, adds a quadratic expenditure term to the equation.

²Linear Almost Ideal Demand System model uses the same analysis as QUAIDS with the exception of applying a linear expenditure term instead of quadratic.

border trade after January 2018 (Bloch-Budzier, 2018; Criscone, 2018). However, taking into account that Norwegian demand is much smaller than the Swedish demand, the effect on Swedish prices and Swedish demand would be negligible. This issue won't be explored in this paper.

Assuming that decrease in quantity demanded translates fully into a decrease in production, unemployment surge can follow the 2018 increase in Norwegian sugar tax (Hu, 2002). An expected decrease in employment has been used by many opponents of health taxes (Alan, 2015; Armstrong, 2016; Genever, 2016). Meanwhile, most of the existing empirical studies on the subject point towards another conclusion. For example, Powell et al. (2014) looked at 2012 tax reform in Illinois and California when the sugar-sweetened beverages (SSB) became taxable at 20% rate. The research was conducted using macroeconomic simulation REMI³ model and accounted for both private and public sector. Powell et al. (2014) found that almost no net employment changes occurred in both states (0.06% in Illinois and 0.03% in California) following new taxation scheme. These results don't support the theoretical economic framework summarised by Hyman (2011).

Generally, the effect of pigouvian health taxes has been more thoroughly studied using the example of alcohol and cigarettes consumption. These studies can be useful in evaluating the effects of sugar taxation on employment on the assumption that sugary products are demerit goods in the same fashion alcohol beverages and tobacco are. Demerit goods are goods that the society considers undesirable for its citizens but that would be overprovided by free markets in the absence of government regulation (Tragakes, 2011). Sugar can be considered a demerit good for a number of reasons. Due to its addictive qualities, it will be easy to sell and over-provide on an unregulated market. Sugar is a cheap and energy dense ingredient added to the majority of food products. Most people aren't being aware of the health costs involved in the consumption of these goods, as evidenced by the wave of obesity-related hospital admissions in recent years (Griffith et al., 2016; World Health Organization, 2017). Using alcohol consumption in the USA as an example of a health tax employment effects, Wada et al. (2017) used REMI estimation to look at causality between health taxes and unemployment. In the analysis, the authors showed that increasing the excise tax on alcohol with 5% would decrease net employment in gross term but not in net terms, as there would be an overall employment gain due to job creation thanks to the reallocation of resources. This confirms the results from Powell et al. (2014) who also points out that the net employment effects of a health tax are almost nonexistent despite a substantial decrease in gross employment in the affected industries.

In addition to that, evidence from tobacco studies further contradicts the hypothesis stating that there is an employment loss following a positive change in a health tax.

³REMI is a dynamic simulation of the effects of a policy on several sectors based on their performance and interaction with each other. The sectors included output, labour and capital demand, demographics, market shares and wages, prices and costs.

Building upon different published estimates of price elasticity of tobacco, Godfrey and Maynard (1988) predict direct and indirect reductions in employment in the British tobacco industry. The authors estimate that a 10% increase in tobacco tax each year could result in 3700 fewer jobs in the British tobacco industry but acknowledge that the net effect for the economy as a whole can be negligible due to job creation in other sectors. Most importantly, shifts in demand and labour requirements associated with the two different patterns of consumption will determine how the net employment change would realise.

Finally, by looking at the Mexican manufacturing industry, commercial sector and general unemployment rate, Guerrero-López et al. (2017a) found that net unemployment remains unchanged after the introduction of 2014 tax schedule on unhealthy foods due to offsetting job creation in different sectors. This recent paper inspired the current work as it used ITSA to evaluate the changes in employment in relevant industries and produced results highly consistent with REMI estimations.

Altogether, the current state of research shows that there is substantial empirical evidence contradicting the macroeconomic theory of health taxes contribution to an employment decrease.

3 Data

In this section sources of information and variables are being described.

All of the numerical data comes from Statistisk Sentralbyrå - Statistics Norway. Statistics Norway is the official Norwegian institution for data collection and publishing. StatBank is a public tool available on the Statistics Norway website and allows for customised data extraction. The quarterly data on employment and unemployment in relevant sectors had been generated using StatBank. This paper uses data on industry employment between January 2016 and September 2018 by the end of each quarter. National unemployment shows the number of registered unemployed between January 2015 and September 2018 by the end of each quarter.

Industrial division of the employees in StatBank has been made according to SIC2007, an industrial classification system adopted by Statistics Norway in 2011. SIC2007 does not provide industrial classification below four digits, which means that there is some limitation to the relevance of the data used in the paper. However, because of the significant time and resource scarcity, a simplification had to be made where the lowest available industrial division from StatBank is used as a proxy for the underlying trends and changes on a more detailed, specific and unavailable industrial sectors (Gimming et al., 2011).

In this analysis, four sectors are being identified as relevant based on the groups selected by Guerrero-López et al. (2017a). Food products manufacture, beverages manufacture, wholesale trade and retail trade (excluding motor vehicles and motorcycles) are being specifically studied under the assumption of being reasonably informative about the true employment sensitivity to changes in prices of sugar and sugary products.

On the industrial level, data on employment in wholesale trade and retail trade are considered to be directly connected to the sales of sugar. At the same time, not all of the wholesale and retail trade sectors can be connected to sugar and sugary products. For example, wholesalers of other commodities such as wood or textiles wouldn't have been affected by a change in the prices of sugar. SIC2007 allows only for exclusion of employees from companies occupied with motor vehicles and motorcycles. Since these are considered to remain unaffected by any sugar taxes, the numbers on wholesale and retail trade employment excluding motor vehicles and motorcycles had been used throughout the analysis. This attempts to give a clearer picture of the effects of the change in sugar tax. A large number of wholesalers depend on sugar as an unprocessed commodity that is sold to manufacturing companies. Moreover, several major product groups such as confectionery, sugary beverages and candy, characterised by high sugar content, are often sold to smaller trade units such as supermarkets, local stores and kiosks. The retailers in turn sell sugary drinks, candy and other sugar products directly to consumers and

have to bear the impact of higher purchase prices. On the assumption that a change in sales translates outright into a change in production and an adjustment of the number of employees, the two groups can be expected to react to a higher sugar tax (Hu, 2002).

Furthermore, a large share of manufacturers within food products and beverages sector is dependent on sugar as an important ingredient. The paper assumes that employment in the two sectors can be used as a sensible proxy for changes in employment that vary with the tax levels on sugar. As Table 1 shows, the greatest price change occurred in the sugary-products sector which faced almost a doubling of the prices of sugar-processed products in 2018 (Finansdepartementet, 2017). After January 2018, general sugar-containing food products faced an 83% increased sugar tax level and all the beverages, either naturally or artificially sweetened, faced a 43% increase in sugar tax level. Beverages such as beer, soft drinks, juice and coffee rely heavily on added sugar as a raw ingredient. Increasing the tax in all Norway in January 2018 should affect this sector as well. This paper makes the crucial assumption that all sugary products should react to prices changing as a result of the increase in the level of tax on sugar.

Using the data on national unemployment, the overall trend in the number of people engaged in Norwegian economy is being controlled for. Comparing the direction of the effect in the analysed industries to the effect on the national unemployment as a whole can help in evaluating the internal validity of the results.

Table 1: A Table showing the development of tax on sugar and processed sugary products in Norway across the recent years (Finansdepartementet, 2017).

Year	tax per kg of sugar (NEK)	tax per kg of sugary products (NEK)
2012	7.05	18.21
2013	7.18	18.56
2014	7.32	19.31
2015	7.49	19.31
2016	7.66	20.19
2017	7.81	20.19
2018	7.93	37.32

4 Methods

This section addresses methodology of the empirical estimation used in the analysis.

This paper uses interrupted time series analysis (ITSA) to evaluate the effect a higher tax on sugar has on employment in Norway.

ITSA is a study design optimal for situations when a government intervention (used as treatment) has been implemented at a given point in time to a certain population (used as treatment and control group). On the national level, random assignment of treatment proves often too difficult or impossible to obtain. Using ITSA allows for isolating pre- and post-treatment trends in order to compare them and obtain the effect of treatment. The design has been discussed in more detail by Biglan et al. (2000); Linden and Arbor (2015); Penfold and Zhang (2013); Wagner et al. (2002); Wang et al. (2013). The principle of an ITSA study is establishing a trend pre- and post-intervention for the same group with a discontinuity at the time of the intervention. Using the hypothetical development of the pre-intervention trend as a control group, or counterfactual group, the potential effect of the treatment is evaluated.

For the evaluation of the Norwegian policy change, the paper assumes the increase in the tax on sugar as intervention and Norwegian labour force in different sectors as treated population. ITSA design can be seen as appropriate for the following reasons:

- the timing of the sugar tax policy change is clearly defined by Finansdepartementet (2017) to be the first of January 2018. This provides a well-defined pre-treatment period (years before 2018) and post-treatment period (year 2018 and onward).
- the outcome of the policy change can be relatively quick to realise as employment in the concerned sectors of the economy is responsive to changes in product prices, as documented by previous empirical studies in Colchero et al. (2015); Guerrero-López et al. (2017b). Moreover, in Norway, the average dismissal time for a worker is one month, unless stated otherwise (The Norwegian Directorate of Integration and Diversity, 2019). This means that if production levels change, employment levels can be adjusted soon after the decisions were been implemented and the effects will be visible quickly.
- the data requirement is sufficiently satisfied by the employment statistics from across industries over time, available from Statistics Norway. Wagner et al. (2002) points out however that evaluating the results of an ITSA with a limited number of data points must be very careful. This remark is discussed in section 7 of this paper.

With just one group under observation, ITSA framework has been summarised by Linden and Arbor (2015) in the following segmented regression:

$$Y_t = \beta_0 + \beta_1 T + \beta_2 X_t + \beta_3 X_t T + \sum_k \mu_k Z_{kt} + \epsilon_t \quad (1)$$

where:

Y_t is defined as the outcome variable,

T is defined as the time trend variable

X_t is defined as the treatment dummy, where $X_t = 1$ when the higher tax was in place and $X_t = 0$ before that

$X_t T$ is defined as the interaction term between the dummy activated at the beginning of the treatment period and the time trend variable. In the analysis conducted in this paper, $X_t T = X_t(T - 8)$ or $X_t(T - \text{start of the treatment period})$

Z_{kt} is defined as control explanatory variables included in the model

ϵ_t is defined as the error term

β_0 is defined as the baseline intercept for the control group when $T=0$

β_1 is defined as the pre-tax time trend

β_2 represents the change in the intercept of the outcome variable after the higher tax was implemented

β_3 represents the change in the slope of the regression line after the higher tax was implemented

μ_k represents other k parameters associated with control variables in the model measured in t periods

Equation 1 produces a regression function such as in Figure 2, where dependent variable is a function of time. The vertical, dotted line depicts the treatment time, or January 2018 when the higher sugar tax was implemented. The initial intercept of the Function 1, β_0 , is the value of employment in a chosen sector before the tax was increased. The line to the left of the threshold has a slope of β_1 and represents the trend in absence of tax changes (pre-tax trend). Change in taxation level shifts the intercept of the function to β_2 and the change in trend is equal to β_3 . A change in the intercept implies an immediate effect of the intervention or a short-term effect of a higher sugar tax. The new post-tax trend, depicted by the line to the right of the cutoff, has a slope of $\beta_1 + \beta_3$. A change in slopes implies a long-term effect where β_3 allows for assessment of the sustainability of the effect the treatment had (Wang et al., 2013).

In the segmented regression, no control variables were used. The error term ϵ_t , also referred to as disturbance term, contains the unobserved variables. These could have also affected employment in different sectors at the time a higher tax was introduced but weren't included into the regression.

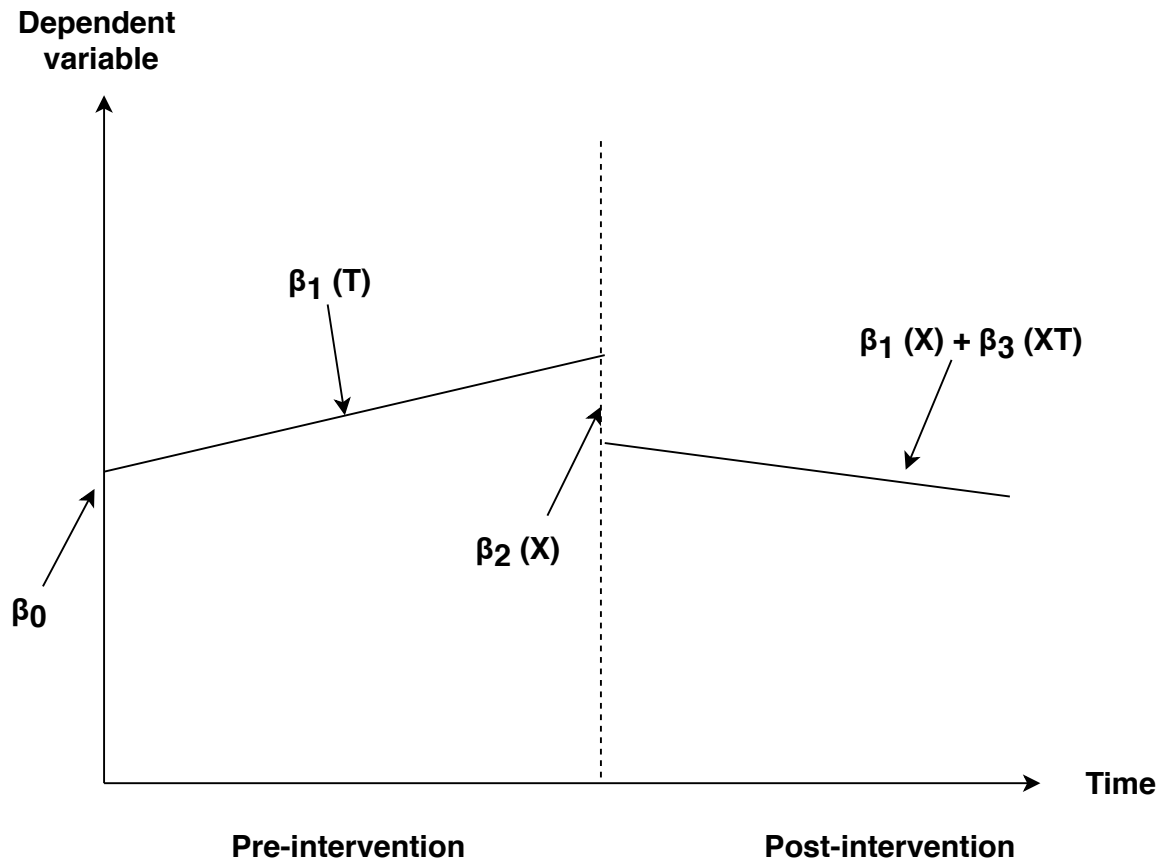


Figure 2: Visual depiction of a single group ITSA.

For employment in each sector, a separate analysis was conducted. Each analysis produced a different regression function, where the outcome variable was employment in food products manufacturing, beverages manufacturing, wholesale and retail sales trade respectively. Additional regression such that the outcome variable is national unemployment was conducted as well to control for underlying nation-wide trends. As a result, 5 different outcome variables were used in total, each with a separate ITSA regression.

In ITSA, the problems characteristic for time series can confound the value of true estimates. Seasonality, autocorrelation and trending variables are the most serious methodological issues (Penfold and Zhang, 2013; Wagner et al., 2002).

1. *Trending variables.* A time series exhibits trending variable if there is a general increase or decrease in the series throughout the sample (Verbeek, 2008, chap.4). Employment usually fluctuates with time and does not display any consistent time trends. In order to account for eventual time trend, the time variable with coefficient β_1 has been included into each ITSA as a part of the research design in Equation (1).
2. *Seasonality.* Seasonal patterns is defined as any pattern in the data that repeats itself over known, fixed periods. Quarterly data can produce biased coefficients if seasonality is present due to various factors. For example, employment can increase in summer quarter due to warm weather that stimulates beverage sales and persists over the years in a repetitive form. Using deseasonalised data as a dependent variable in the respective regressions accounts for the seasonality by using the variation in the data independent of seasonal effects.
3. *Autocorrelation.* For time series data, values of the same variable in different time periods can be intercross-dependent on each other across time. It is referred to as autocorrelation. Time variables have a tendency to repeat themselves - if unemployment in a sector of an economy was on the rise in the past, there is some nonzero probability that it is going to continue to rise in time periods that follow. If variables in the regression are highly persistent, coefficient estimates would be inconsistent (Verbeek, 2008).

Several countermeasures are being accounted for with regard to the autocorrelation of the data. This paper will look at correlograms, autocorrelation of the process and Durbin-Watson statistic in order to account for the issue. Correlograms plot sample autocorrelations of a variable against its time lags in order to check for randomness, trends and seasonal patterns. Plotting correlograms gives an idea of how serious an issue autocorrelation is. Data on each dependent variable has been used to create different correlograms which can be found in the appendix section A.

Another way of looking at autocorrelation of variables is to look at their autoregression of the process lag 1, or AR1. Estimating correlation between a variable and its first lag indicates how much of the variation within the variable can be explained by its one-period delayed copy. To perform AR1, the following equation can be estimated according to Verbeek (2008):

$$Y_t = \delta_1 Y_{t-1} + \theta_t \quad (2)$$

where:

Y_t is defined as the outcome variable in time t

Y_{t-1} is defined as the time trend variable one period before t

δ_1 is defined as a constant

θ_t is defined as an error term

A variable is assumed to be highly persistent if δ_1 coefficient is close to 1 or -1. High values of δ_1 indicate that variables aren't stationary and that autocorrelation might be an issue. In this paper, variables so that $\delta_1 \notin [-0.8, 0.8]$ are assumed to be highly persistent and potentially cause the estimators to be inconsistent. Variables with $\delta_1 \in [-0.8, 0.8]$, or closer to zero, are considered to be weakly dependent and safe to use. The exact thresholds of the interval however vary dependent on the researcher and their field of study.

Durbin-Watson (DW) statistic tests the null hypothesis that the residuals aren't autocorrelated against the alternative that the residuals follow an AR1 process according to Equation (2). The DW statistic takes on values between 0 and 4. A value realised close to 2 indicates no autocorrelation; a value between 0 and 2 indicates positive autocorrelation; a value between 2 and 4 indicates negative autocorrelation (Linden and Arbor, 2015). No general rule has been established for the threshold indicating serious autocorrelation. Typically, DW statistics realising between 1.5 and 2.5 is assumed to be no source of autocorrelation concern. This rule of thumb is going to be used in the next section to control for autocorrelation of dependent variables.

5 Results

In this part of the paper main results of the empirical study are presented. The significance level is assumed to be $\alpha = 0.05$ throughout the rest of the paper.

5.1 Autocorrelation

Correlograms for food products, beverages, wholesale and retail trade had been obtained and can be found in the Appendix section A. All four correlograms of employment in the analysed sectors highlighted some autocorrelation at lag one (AR1) and two (AR2) so the analysis was adjusted to allow for autocorrelation up to the second lag. National unemployment data exhibits strong autocorrelation at lag 1, which is why a lagged dependent variable was included into ITSA regression as a control variable.

To further investigate the issue of autocorrelation, the autocorrelation of the process was looked at as well as Durbin-Watson statistic included as a formal test for autocorrelation.

Table 2: The results of the autocorrelation of the process and Durbin-Watson statistic for autocorrelation of dependent variables.

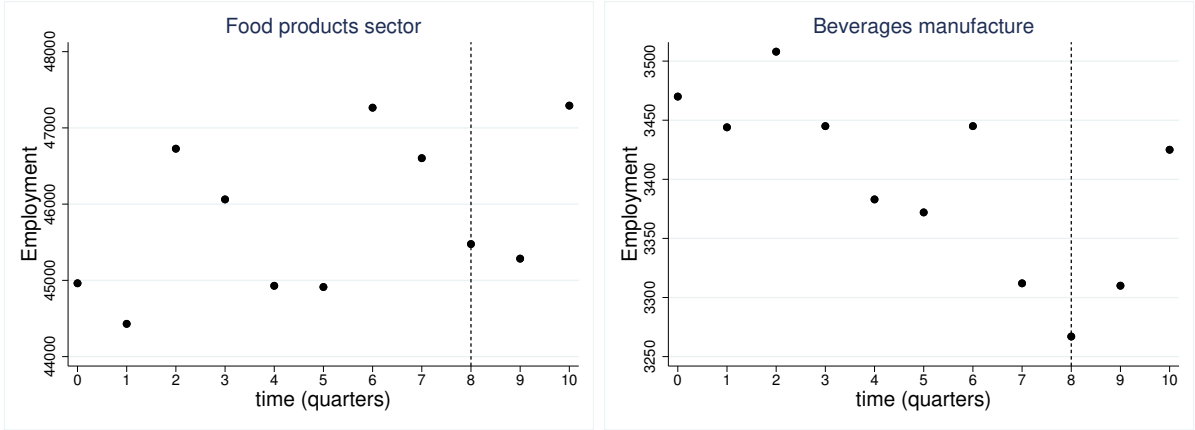
outcome variable Y_t :	AR1 (δ_1)	Durbin-Watson statistic
employment in food products sector	0.1381	1.611454
employment in beverage sector	0.1892	2.379067
employment in wholesale trade	0.4469	1.545292
employment in retail trade	0.1044	1.651352
national unemployment	-0.1688	0.775285

Source: author's estimations done using Stata 13. Command *dwstat* was used for Durbin-Watson test statistics and *corr var L.var* for AR1, according to Equation (2).

As shown in Table 2, most of the data on dependent variables were found to be weakly dependent based on the obtained coefficients in autoregressive models order one (AR1). Employment in the wholesale trade sector exhibits higher δ_1 but the value is within the threshold accepted in this paper.

The DW statistics are summarised to the right of AR1 values for all the detrended dependent variables. Based on the results for industry data, ITSA allowed for lag 2 of the employment in different sectors to correct for autocorrelation. In the analysis of national unemployment data, the command was allowed to control for lag 3 and one-period lagged dependent variable was used as explanatory variable.

5.2 Employment in the food sector & in the beverages sector



(a) Employees in food manufacturing sector in Norway since January 2016. (b) Employees in beverage manufacturing sector in Norway since January 2016.

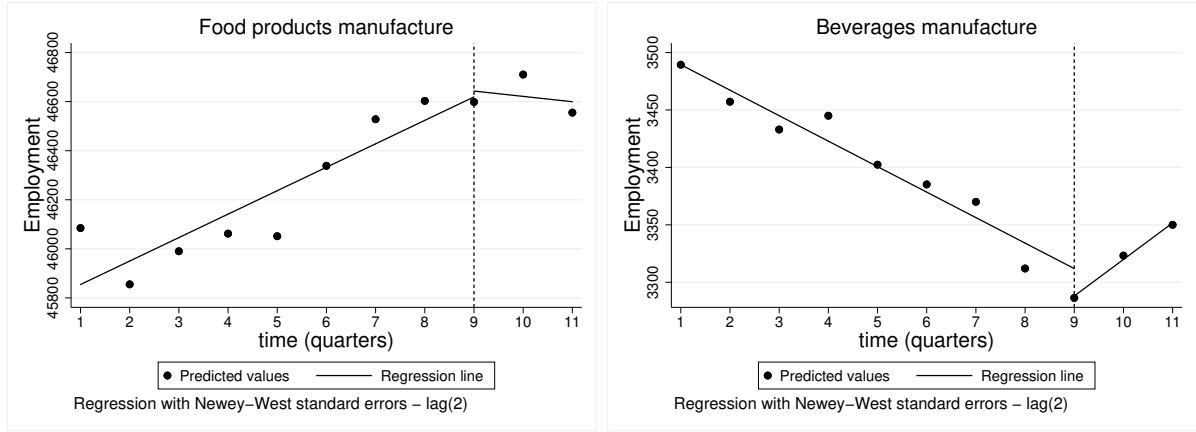
Figure 3: Data on employment in food products and beverage manufacturing sectors before and after January 2018.

Source: author's estimations done using data from Statistics Norway.

The quarterly number of employees in Norway between January 2016 and September 2018 are shown in Figures 3a for the food sector and 3b for the beverages sector. The vertical line at the eight month represents the time at which the treatment, a higher tax rate on sugar, was implemented. The data looks like there is some seasonality pattern in both Figures. To formally test for seasonality a joint significance test was conducted on quarterly dummies. The evidence suggested that both food sector and beverage sector data exhibits seasonality. Subsequently, the seasonal variation was accounted for in the ITSA regression.

Having tested for autocorrelation of the dependent variables and seasonality, ITSA has been conducted. Figure 4a shows the data on food products sector where seasonality has been corrected for and the obtained data plotted against time. The graph shows clearly that ITSA fitted an increasing linear trend before the tax was introduced and a subsequent decreasing linear trend. There seems to be a change in slopes before and after the sugar tax was increased. Almost no change in the intercept can be seen in the Figure 4a.

The analysis conducted using the data on employment in beverages manufacturing sector produced Figure 4b. In this industry, just like in the graph showing the food products sector, the trends in employment seems to have changed direction after the treatment period. After January 2018, there seems to be an upward trend in the employment. Before the tax was introduced, the trend was declining. This can be seen clearly around the dotted vertical lines, where a linear trend produced with deseasonalised data turns around after the ninth quarter.



(a) Employees in food manufacturing sector in Norway since January 2016. (b) Employees in beverage manufacturing sector in Norway since January 2016.

Figure 4: ITSA conducted with deseasonalised data on employment in food products and beverage manufacturing sectors.

Source: author's estimations done using data from Statistics Norway.

Table 3: Estimated changes in employment in food and beverage sectors of Norwegian economy before and after sugar tax was increased

outcome variable Y_t	Employment in Food Products		Employment in Beverages	
	coefficient (95% CI)	p-value	coefficient (95% CI)	p-value
intercept β_0	45854.69 (45459.73;46249.65)	0.000	3489.438 (3411.936;3566.939)	0.000
pre-tax trend β_1	95.5625 (17.28982;173.8352)	0.028	-22.1875 (-29.43327;-14.94173)	0.001
intercept change β_2	23.875 (-626.6852 ;674.4352)	0.924	-23.875 (-64.33576;16.58576)	0.177
post-tax trend change β_3	-117.25 (-514.2719;279.7719)	0.458	54 (33.47509;74.52491)	0.002
post tax trend $\beta_1 + \beta_3$	-21.6875 (-409.7821;366.4071)	0.8842	31.8125 (10.5725;53.0525)	0.0142

Source: author's estimations done using Stata 13.

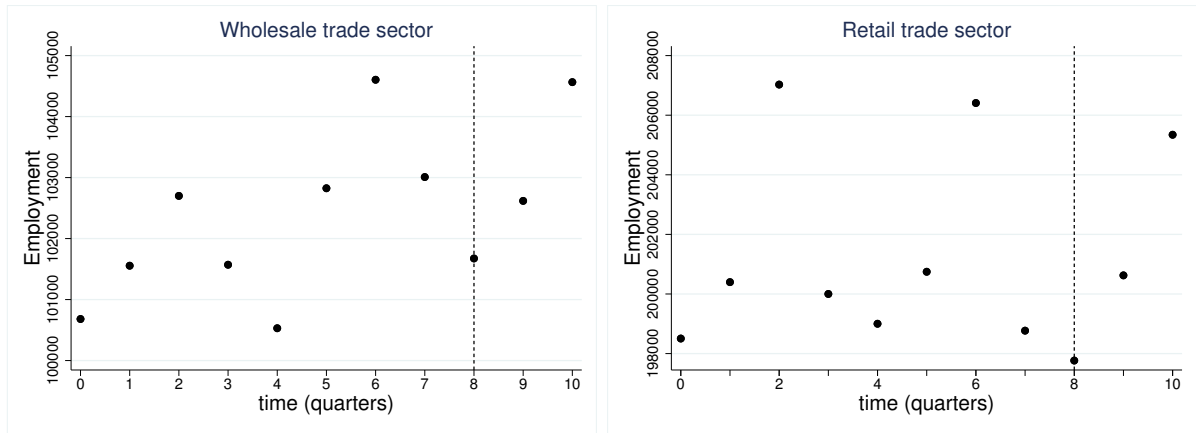
Table 3 presents the results of ITSA regression (depicted in Figures 4a, 4b), where deseasonalised data was used.

Analysis conducted using data on employment in food products manufacturing sector found no significant difference in trends before and after the treatment period. The post-treatment trend, represented by $\beta_1 + \beta_3$, isn't statistically significant. A higher tax rate on sugar hasn't been found to produce any long-term changes. Intercept change, represented by β_2 , isn't statistically significant either. There is not enough evidence to claim that a change in tax produced any immediate effects on employment in food manufacturing.

The results of the analysis conducted using the data on employment in beverages manufacturing sector can be seen in Figure 4b. The data exhibits less of a seasonal pattern than food products employment and no clear time trend. In this industry, the trends in employment seems to have changed direction after the treatment period - after January 2018, there seems to be an upward trend in the employment. Before the tax was introduced, the trend was declining. This can be seen more clearly around ninth quarter in Figure 4b, where a linear trend produced with deseasonalised data turns around and becomes positive. Short-term employment changes in the beverages manufacturing sector aren't statistically significant, as documented by a high p-value of β_2 . There seems to be some long-term effect of the higher sugar tax rate, documented by a statistically significant post-tax trend represented by $\beta_1 + \beta_3$. The change in slope, β_3 , is positive and equal to 54. This means that on average, the change in employment in the beverages sector associated with each quarter after the tax was raised was 54 employees more than before the tax was changed. Seen in the context of Norwegian employment statistics, 54 employees correspond to less than 1.5% of the average employment in the beverages manufacturing sector in 2018. This is a small number but what is most surprising is that the direction of the employment trend changed after the tax was raised. Possible reasons for this will be explained in the next section.

The findings above imply that there is little evidence of that the 2018 change in sugar tax had any effect on employment in the food sector in Norway. Beverages manufacture could experience some positive long-term effects of a higher sugar tax. However, due to data scarcity on post-tax employment, further studies are needed to confirm this result.

5.3 Employment in the wholesale trade sector & retail trade sector



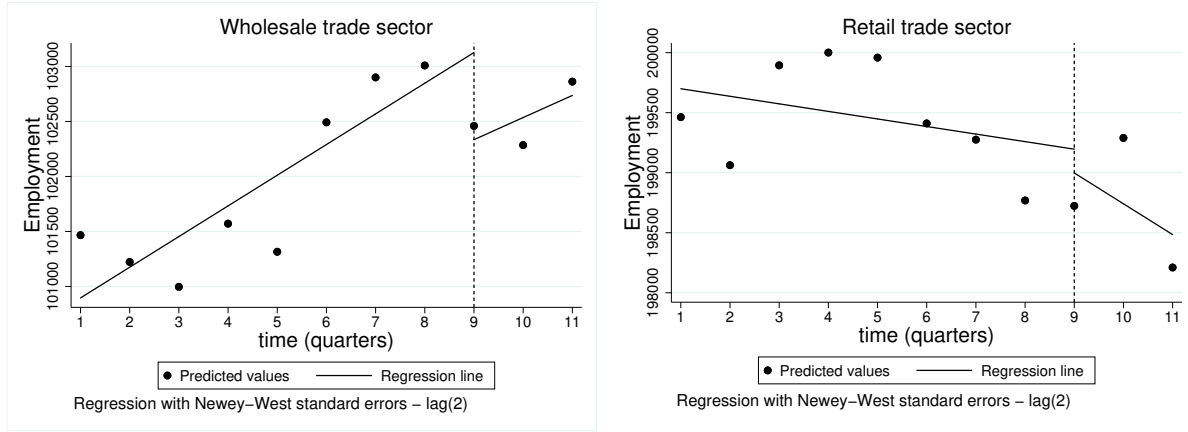
(a) Employees in the wholesale trade sector in Norway since January 2016. (b) Employees in retail trade in Norway since January 2016.

Figure 5: ITSA showing the deseasonalised regression of data on employment in wholesale and retail trade sectors before and after the sugar tax was increased.

Source: author's estimations done using data from Statistics Norway.

Figures 5a and 5b depict the statistics on the number of employees working in the wholesale trade sector and retail trade sector respectively since January 2016. The vertical line at the eighth month represents the time at which the treatment, a higher tax rate on sugar, was implemented. Employment in both figures seems to exhibit some kind of seasonality, where the largest number of employees appears to have been registered in the middle of each year. This can be seen by tracing the data points on the graphs.

Having tested for autocorrelation of the dependent variables and seasonality, ITSA has been conducted. Figure 6a illustrates steeply increasing trends in employment in wholesale trade before and after the treatment. Figure 6b seems to present declining, flatter time trends in employment in retail trade sector both before and after the sugar tax was increased. Both sectors seem to have experienced a change in employment following the introduction of the higher sugar tax, but the graphs themselves can't reveal whether the changes were statistically significant.



(a) Deseasonalised data on employees in whole- (b) Deseasonalised data on employees in retail sale trade sector in Norway since January 2016. trade sector in Norway since January 2016.

Figure 6: ITSA showing the residuals from deseasonalised regression of employment in wholesale and retail trade sectors before and after the sugar tax was increased.

Source: author's estimations done using data from Statistics Norway. Both graphs were constructed using *ITSA* command in Stata 13.

Table 4: Estimated changes in employment in wholesale and retail trade sectors of Norwegian economy before and after sugar tax was increased.

dependent variable Y_t	Employment in Wholesale trade		Employment in Retail trade	
	coefficient (95% CI)	p-value	coefficient (95% CI)	p-value
intercept β_0	100895.9 (100099;101692.8)	0.000	199699.7 (198898;200501.4)	0.000
pre-tax trend β_1	278.8127 (111.4353;446.1901)	0.006	-62.93713 (-241.7729;115.8986)	0.433
intercept change β_2	-791.9598 (-1524.95;-58.96958)	0.038	-198.128 (-1053.281;657.0253)	0.601
post-tax trend change β_3	-77.75019 (-379.2539;223.7535)	0.561	-193.7504 (-759.3963;371.8956)	0.445
post tax trend $\beta_1 + \beta_3$	201.0625 (-12.9548;415.0798)	0.0617	-256.6875 (-725.8934;212.5184)	0.2368

Source: author's estimations done using data from Statistics Norway.

Table 4 presents the results of ITSA regression with deseasonalised data. In the wholesale trade sector, the employment data produced a large, statistically significant coefficients of pre-tax trend and a smaller, statistically insignificant post-tax trend. The short term change indicator, β_2 , is statistically significant and equal to -791.9598. This means that according to the evidence presented above, immediately after the higher tax was introduced, the wholesale trade sector employed about 792 people less than before 2018. In the context of the whole sector, this corresponds to less than 1% of the average

number of worker. This change can be seen as small, and temporary, as documented by insignificant long term indicator, $\beta_1 + \beta_3$. Therefore there isn't enough evidence to claim that the 2018 change in tax had any long term effect on employment in wholesale trade sector in Norway. However, some short term changes could have been discovered. At the same time, due to data scarcity on employment after January 2018, further studies are needed to confirm the results.

The data containing employment statistics for the retail trade sector didn't produce any statistically significant coefficients. Intercept change and post-tax trend were both found to be insignificant. These results suggest that there isn't enough evidence to claim that the 2018 change in tax had any short- or long-term effect on employment in retail trade sector in Norway.

6 Validity of the results

This section presents the robustness tests conducted in this paper as well as discusses external and internal validity of the results.

External validity refers to the extent to which the results can be generalised and used by other communities. Other academic work concerned with the same subject, such as Guerrero-López et al. (2017a); Powell et al. (2014), produced results partly similar to the results presented in this paper. Neither Mexican nor Norwegian sugar taxes seem to cause lower employment in the majority of sugar-dependent industries. International experience on alcohol and tobacco taxes, exemplified by Godfrey and Maynard (1988); Hu (2002); Wada et al. (2017), show more variation in their findings. A reason for this might be that the employment sector connected to tobacco or alcohol differ more significantly from sugary products and has a greater capacity to withstand increased raw material prices.

Internal validity refers to how accurate the results are and whether the observed results are caused by an independent variable or some other confounding factor. The confounding factor can be compared to an omitted variable bias when an important explanatory variable is included into the error term.

Robustness tests do not add any information on causality in question but they are helpful in discovering omitted variables that could have confounded the results from the conducted ITSA. In order to test the correctness of the results, different kinds of robustness analysis were conducted: a pseudo-intervention test, a time trend specification test and an analysis of national unemployment.

6.1 Pseudo-intervention robustness test

Empirical models with regression discontinuity such as ITSA widely apply a simple yet effective robustness check called pseudo-intervention regressing. While performing a pseudo-intervention on ITSA, the treatment time was altered to an earlier period than the period during which the real treatment took place. The robustness test looked for statistically significant intercept change or post-tax trend change in the pseudo-intervention regressions. If any of these were found to be significant, then "any significant changes in the outcome of the true treatment unit cannot be attributed to the intervention" (Linden, 2018).

Using the original regression according to Equation (1), the robustness checking regression set X_t to be the treatment dummy equal to one a year before the actual higher tax was in place (to January 2017) and zero before that. The year 2017 was used because it contains data on employment closest to the analysed date. There is a chance that some trends which continued throughout 2018 did already exist by 2017. This would

make the conditions of pseudo-intervention as similar to the real intervention as possible. The results of the robustness analysis can be found in the first column of the Table 6 located in the Appendix section C. For data on food products manufacturing employment, the pseudo-intervention produced significant intercept change and post-tax trend coefficients. The post-tax trend was also found to be significant in beverage employment and retail sales employment data. This implies that the internal validity of the results is questionable.

6.2 Time trend specification robustness test

Robustness testing is also used to look at how the conclusions of an analysis change when the underlying assumptions are altered. Applying the correct specification of the regression equation is one of the crucial assumptions of the ITSA model. If regression form was misspecified, the obtained coefficients will be biased (Verbeek, 2008). To further investigate the issue of validity of the results, the assumption of linearity of the time trend was tested against a hypothetical quadratic or cubic time trend. In order to do that additional regressions were conducted. Since the original regression uses the assumption of a linear time trend, conducting the analysis according to the Equations 3 and 4 produced coefficients that can be informative about the robustness of the original results.

The original results of regression according to Equation 1 are presented in Tables 3 and 4. Coefficients obtained with regressions according to Equations 4 and 3 are summarised in the Appendix C, in Table 6. Second column to the right in Table 6 contains the results of adding a quadratic term to the original regression according to the following :

$$Y_t = \beta_0 + \beta_1 T + \beta_2 X_t + \beta_3 X_t T + \beta_4 T^2 + \sum_k \mu_k Z_{kt} + \epsilon_t \quad (3)$$

Comparing coefficients from ITSA according to Equation (1) to coefficients in Table 6, one shouldn't find significant results in the latter if the specifications were right from the beginning.

Using data from food products manufacturing industries, the employment coefficient indicating a short-term effect of the treatment β_3 wasn't found to be statistically significant. Long-term indicator, $\beta_1 + \beta_3$, was significant. Similar results were produced by the data from the beverages manufacturing sector, retail trade sales and national unemployment. In wholesale trade employment data, after including a quadratic time trend, a significant intercept change coefficient was found but no significant post-tax trend.

In a similar manner, a cubic time trend specification has been tested for. In Table 6, the third column to the right adds a quadratic and a cubic term to the original ITSA

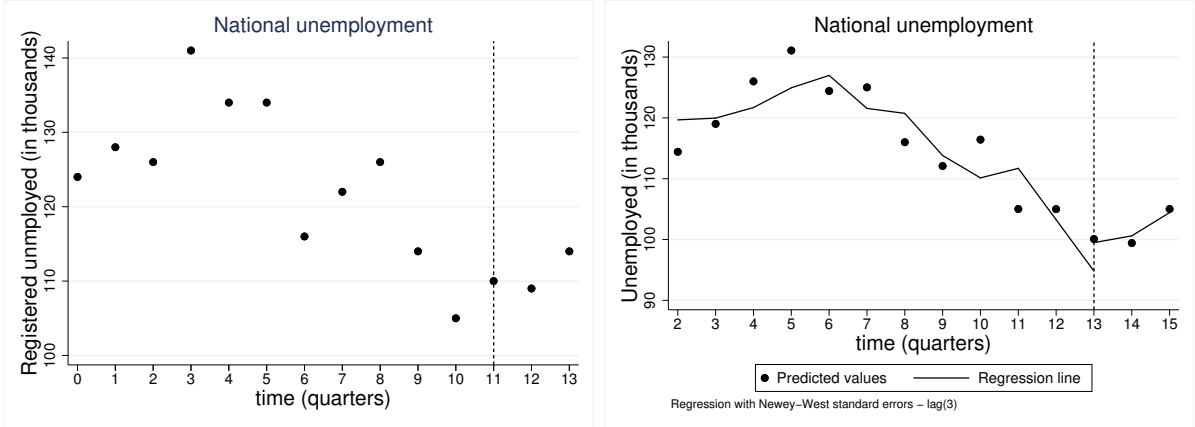
equation according to :

$$Y_t = \beta_0 + \beta_1 T + \beta_2 X_t + \beta_3 X_t T + \beta_4 T^2 + \beta_5 T^3 + \sum_k \mu_k Z_{kt} + \epsilon_t \quad (4)$$

The findings of that regression include post-tax trend coefficients that are statistically significant for all of the data about the employment except for wholesale trade. The fact that altering time trend variable results in significant β_2 and β_3 coefficients is a sign of that the employment effects found in this paper can be independent of the sugar tax increase.

6.3 National unemployment

The data on national unemployment has been analysed in order to control for overall trends in the Norwegian labour market. Statistically significant coefficients of intercept change or post-tax trend would indicate that some changes were under way in Norway at the time sugar tax was increased. Most probably these changes can't be attributed to a change in sugar tax because of the small number of companies the tax really affects. However, finding significant coefficients in the unemployment analysis can indicate that the changes on national level could have affected sectors studied in section 5 and confounded the results.



(a) National unemployment in Norway since January 2015. (b) ITSA regression of registered unemployed in Norway since January 2015.

Figure 7: **Figures showing the registered unemployed in Norway since January 2015.**

Source: author's estimations done using data from Statistics Norway.

Figure 7a shows the number of registered unemployed in Norway between January 2015 and September 2018. The data seems to present a seasonality pattern and to be declining between 2015 and 2017. After January 2018, the number of registered unemployed seems to be on the rise which corresponds to smaller general employment.

Using the data on national unemployment and controlling for seasonality and one-year lagged value, Figure 7b was obtained. The graph shows weakly declining pre-tax time trend. The vertical line at the thirteen month represents the time at which the treatment, a higher tax rate on sugar, was implemented. As shown in Figure 7b, the trend in national unemployment in Norway has been slowly declining before January 2018. Afterwards, an increasing trend was obtained with ITSA.

Table 5: Estimated changes in national unemployment in Norway since January 2015 (in thousands).

dependent variable Y_t	National Unemployment	
	coefficient (95% CI)	p-value
intercept β_0	48.38612 (-8.655111;105.4273)	0.087
pre-tax trend β_1	-1.191713 (-2.162746;-0.2206791)	0.022
intercept change β_2	-2.56597 (-6.518042;1.386102)	0.176
post-tax trend change β_3	5.433723 (4.135576;6.73187)	0.000
post tax trend $\beta_1 + \beta_3$	4.2420 (2.5866;5.8974)	0.0003

Source: author's estimations done using data from Statistics Norway. The model were adjusted for seasonality and one-year lag of dependent variable.

Table 5 summarises the coefficients obtained with the ITSA regression. The immediate change after the higher tax was introduced, depicted by the intercept change β_2 , isn't statistically significant, which implies that there isn't enough evidence to claim that the tax change had any short-term effects. At the same time, the post-tax trend and the change in trends are statistically significant ($\beta_1 + \beta_3$ and β_3 have p-values close to 0.000). This suggests that there might be some long-term effect the higher sugar tax had on the national unemployment in Norway. The post-tax trend change was positive, which would imply that after the sugar tax was increased, national unemployment increased. However, general unemployment is usually subjected to several economic variables, most of which were not held constant during the intervention. The long-term change in unemployment trends ought to be attributed to other national as well as global phenomena or other omitted variable that the paper was not able to control for. This would confound the findings section 5. The national unemployment analysis suggests that further studies with richer data sources should be used to confirm the results from this paper.

6.4 Potential pitfalls

As evidenced by the results of all the robustness tests, the internal validity of the findings from this paper is fairly low. Therefore, caution must be taken with regard to the interpretation of the results in this paper. A number of reasons for the inaccuracy of the discovered employment effects connected with the increased sugar tax can be listed:

1. *The nature of the industry under study.* The complexity and size of the industry studied in this paper pose some challenges to the validity of the results. Food, beverages and tobacco, a group classified in SIC2007 as a whole, contribute to less than 2% of the whole Norwegian national output. This was about 53 160 employees in 2001 or 1.88% of the current labour force. In industrialised economies, the confectionery sector (including ice cream and chocolate) isn't as labour intensive as in developing countries. For example, in Germany, the confectioneries stand for less than 8% of the food sector compared to the rest of the food industry (BDSI, Association of the German Confectionery Industries, 2018). Statistics Norway (2019) reports that in Norwegian economy, the labour force is primarily engaged in human health and social work activities as well as repair of motor vehicles and motorcycles. This can be seen clearly in Figure 10 in Appendix B. The very modest size of the workforce employed by the sugary products industry implies that even a significant change would only have a negligible effect on sector employment compared the food sector as a whole. Because of that, the impact of the sugar tax on employment can be so small that it won't be possible to distinguish it from other trends in the overall manufacturing employment data. Even though the data was carefully chosen to exclude motor vehicles and motorcycles, ITSA could still pick up other, unobserved changes in SIC2007-classified employment available at Statistics Norway. In countries where the confectionery sector is larger or more labour intensive, an ITSA employment regression could provide more exact results.
2. *The nature of ITSA.* The methodology applied in this paper can also contribute to biased results. Despite being a very useful tool in evaluating national policies, ITSA can in itself become a source of limitation.
 - (a) *Nature of the control group.* ITSA violates experimental design by omitting control group and instead using pre-intervention trend as a counterfactual group. An issue connected with that was identified as instrumentation by Biglan et al. (2000) and poses a threat to the validity of the paper. The researcher argues that the national policy, having been announced ahead, pre-conditions the counterfactual group even before the treatment is in place and thus alters their behaviour, making the pre-intervention trend an unsuitable counterfactual. If wholesalers and retailers of sugary products expected the

tax to be in place at a certain point in time, they might have adjusted the number of employees and sales volume in advance. Norwegian government announces new budgetary reform before they are implemented so any informed producer can act upon these expectations, altering their own behaviour and the subsequent outcomes measured by economists. If that was the case for sugar tax in Norway after January 2018, the changes shortly before January 2018 in all of the industries presented in Figures 4a, 4b, 6a and 6b would be the result of expectations of a policy, not the policy itself. The national unemployment analysis produced significant coefficients in many industries. This could mean that there is some underlying variable that hasn't been included into the regression that also affected employment in several sectors of the Norwegian economy.

- (b) *Nature of the intervention.* Even though the timing of the new policy was clearly defined, Biglan et al. (2000) points out that the image of the intervention under study will be blurred if any other policy was implemented at the same time. Interactions between policies can't be predicted and it is usually impossible to control for and isolate the results of one policy from the other. Since Norway is an active member of the global economy, even international policy changes such as global sugar farming crisis (compare crisis in 1974) could confound the results of the domestic intervention. These weren't controlled for in the paper due to impracticality and scarcity of resources and time. Looking at other policies that possibly are more isolated could allow for generalisation of the results across countries and disciplines. In case of the Norwegian sugar tax increase generalising the results across countries would probably not be appropriate.
- (c) *Regression specifications.* In order to achieve high internal validity, a correct form of the ITSA regression equation must be applied. Robustness test of the time trend specification didn't succeed in confirming the significance of the results. Changing time trend specification of the ITSA equation shouldn't produce any significant coefficients if the original assumptions were right. This wasn't the case. Perhaps a different set of time specifications should be put in place while choosing the ITSA regression controls. Performing the analysis on several larger data sets could be helpful in choosing the true specification of the time trend.

3. *Scarcity of data.* Unfortunately, Statistics Norway does not provide data on sugary products imported into the country. Lack of information on imports can hinder evaluation of the effect of the higher sugar tax on employment since higher imports tend to imply substitution effect between domestic and foreign sugary products.

Controlling for imports can be a way of eliminating some omitted variables in any of the regressions (Wright et al., 2017). Furthermore, being able to analyse more customised data can contribute to more accurate results. Guerrero-López et al. (2017a) took advantage of industry surveys conducted with a purpose of being used in the study. With more detailed statistics on employment in industries with close ties to sugary products, higher internal validity might be achieved.

7 Discussion of the results

This part discusses the results shown in previous sections. Statistically significant level is assumed to be $\alpha = 0.05$.

No evidence of any significant changes in employment in majority of the relevant industries connected to sugar tax was found in the results. Wholesale trade sector seemed to have experienced a small, short-term decrease in employment following the increase in sugar tax. Beverages manufacturing sector seemed to have experienced some significant changes in the post-tax trend which can be a sign of long-term effects of the tax. This result produced with the data on wholesale trade sector seem to confirm partly the theoretical framework presented in section 2. Surprisingly though, the results obtained from beverages sector data go against the economic theory. This can be plausible due to a number of reasons. First, if a large number of beverages rely on added sugar to a lesser degree, then beverages manufacturing sector won't react strongly to an increase in the sugar tax. Secondly, the data on summer 2018 may confound the results of the post-treatment analysis. Data on employment after the sugar tax was raised consists of only three quarters, as compared to eight quarters of data before the tax was made higher. Summer of 2018 was extremely long and hot, creating a natural spur to beverage sales and thus possibly increasing employment in that sector. The second and third quarter could have acted as outliers, skewing the regression towards higher employment in the post-treatment period. This haven't been confirmed by the national unemployment regression, where post-treatment period exhibited a lower general employment rate. If nationally fewer people were employed after January 2018, the warm summer didn't change that trend. Due to data scarcity, information on the effects of summer 2018 couldn't have been corrected for in this paper. Perhaps future studies can check for the effect of a good summer on beverages sector employment. Finally, beverages manufacturers are becoming decreasingly labour-oriented. It can be argued that this sector may be as immune to the national tax policies changes as similar sectors that rely mostly on capital and machinery. In such case, increasing employment in beverages sector depends on factors other than price of inputs, for example on strength of the workers unions and the price of labour. On the top of that, even if sugar tax did affect production in beverages sector, the diversification of the products sold by most of the manufacturers could allow for a smooth absorption of the extra costs by other product lines (Karlsson, 2018).

In other employment sectors, wholesalers and retailers have usually a greater possibility of adjusting their inventories. This would explain the fact that in the long run, the wholesale trade sector adjusted the number of employed to the pre-intervention level. Also, the fact that retailers usually diversify their products even more than wholesalers can make the extra sugar costs dissolve in profits from other firm branches. This can

cause the effect on the employment in this sectors to be negligible.

8 Conclusion

This paper illustrates the effects a change in the sugar tax in Norway in January 2018 had on employment in different sectors. The evidence suggests that a higher sugar tax did contribute to a decreased employment in wholesale trade sector. At the same time, some positive, long-term changes in the employment in the beverage manufacturing sector were found. A higher sugar tax also corresponds to a significant albeit not large, positive change in the unemployment statistics. The data from food products and retail trade sector didn't produce any evidence of short- or long-term effects of a higher sugar tax. However, none of the significant employment effects could withstand the robustness tests which suggests that strong caution must be taken while reading the outcomes of this ITSA analysis. Further research is required to evaluate the long-term employment effects of a higher sugar tax in Norway. Including more detailed numbers, data on imports and money transfers as well as controlling for time trend specifications could further validate potential research.

In the future, a replication of this paper could conduct an ITSA with more customised and more vast data. Perhaps relying on surveys similar to the ones conducted by Guerrero-López et al. (2017a) can provide information that would make the analysis more accurate. Removing some of the possible trends present in less relevant parts of SIC2007 industrial division could also produce coefficients of higher internal validity. With more time to work with, statistics on imports of particular food groups could also be obtained from sources less accessible than Statistics Norway. Adding controls for imports could extract the effect of the treatment in a clearer way. Moreover, if, available, money transfers records between industrial sectors could also be used to control for the workforce migration following the introduction of a tax, as suggested by Guerrero-López et al. (2017a).

The robustness tests prove that the time trend in the series might not be linear. A carefully chosen specification based on a larger amount of empirical data can greatly add to the internal validity of future results. In addition, Linden (2018) suggests using permutations as a robustness check that further improves causal inference in ITSA. Future work may look into the issue and attempt to use ITSAMATCH package in Stata to evaluate treatment effects.

Another issue worth looking into can be a comparison of sales close to the Swedish-Norwegian border directly before and after the tax was increased in 2018. Using the difference in differences design, a hypothetical study could look at the data from around the region where cross-border substitution effect is the largest. Compared to the parts

of Norway that are located far away from relatively cheaper Swedish sugary products, before and after employment might differ. In this way, additional information on the significance of health taxes for border trade could be obtained.

References

- Alan, Jones**, “Jamie Oliver slammed by Wetherspoons boss for ‘showboating’ on soft drinks tax,” *The Independent*, Oct 2015. Accessed 2018-12-04.
- Armstrong, Ashley**, “Sugar tax will harm jobs and economy,” *The Telegraph Business*, July 2016. Accessed 2018-12-04.
- BDSI, Association of the German Confectionery Industries**, “Infographics: The Confectionery Sector compared - Share of turnover in the German Food Industry in 2017,” 2018. Accessed 2018-12-04.
- Biglan, Anthony, Dennis Ary, and Alexander C. Wagenaar**, “The Value of Interrupted Time-Series Experiments for Community Intervention Research,” *Prevention Science*, Mar 2000, *1* (1), 31–49.
- Bloch-Budzier, Sarah**, “Crossing the border for a sugar fix,” *BBC News*, Mars 2018.
- Brownell, Kelly D., Thomas Farley, Walter C. Willett, Barry M. Popkin, Frank J. Chaloupka, Joseph W. Thompson, and David S. Ludwig**, “The Public Health and Economic Benefits of Taxing Sugar-Sweetened Beverages,” *New England Journal of Medicine*, 2009, *361* (16), 1599–1605. PMID: 19759377.
- Colchero, MA, JC Salgado, M Unar-Munguia, M Hernandez-Avila, and JA Rivera-Dommarco**, “Price elasticity of the demand for sugar sweetened beverages and soft drinks in Mexico,” *Economics & Human Biology*, 2015, *19*, 129–137.
- Criscone, Valeria**, “Sweden sees sweet deal after Norway levies new sugar tax,” *Washington Times*, Jan 2018. Accessed 2018-12-04.
- Escobar, Maria A Cabrera, J Lennert Veerman, Stephen M Tollman, Melanie Y Bertram, and Karen J Hofman**, “Evidence that a tax on sugar sweetened beverages reduces the obesity rate: a meta-analysis,” *BMC public health*, 2013, *13* (1), 1072.
- Finansdepartementet, Norge**, “Avgiftssatser 2018,” 2017. Accessed 2018-11-17.
- Genever, Shana**, “Sugar tax could raise unemployment,” *SA Breaking News*, Aug 2016. Accessed 2018-12-04.
- Gimming, Kristian, Tore Halvorsen, Tor Skoglund, and Knut Ø Sørensen**, “Reviderte nasjonalregnskapstall 1970-2010,” *Økonomiske analyser 6/2011*, 2011.
- Godfrey, Christine and Alan Maynard**, “Economic aspects of tobacco use and taxation policy,” *BMJ*, 1988, *297* (6644), 339–343.

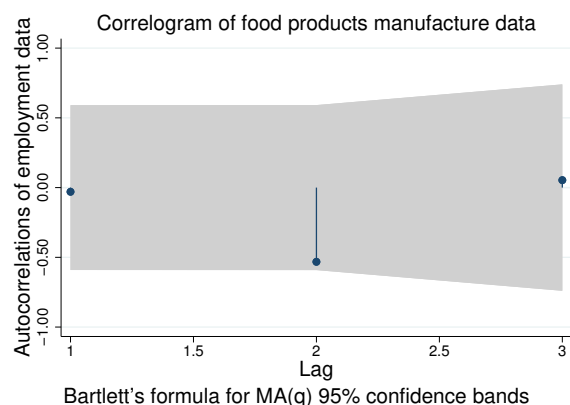
- Griffith, Rachel, Melanie Lührmann, Martin O’Connell, and Kate Smith**, *Using taxation to reduce sugar consumption*, Institute for Fiscal Studies, 2016.
- Guerrero-López, Carlos M, Mariana Molina, and M Arantxa Colchero**, “Employment changes associated with the introduction of taxes on sugar-sweetened beverages and nonessential energy-dense food in Mexico,” *Preventive medicine*, 2017, *105*, S43–S49.
- , **Mishel Unar-Munguía, and M Arantxa Colchero**, “Price elasticity of the demand for soft drinks, other sugar-sweetened beverages and energy dense food in Chile,” *BMC public health*, 2017, *17* (1), 180.
- Hyman, David N**, “Taxes on consumption and sales,” in “Public finance: A contemporary application of theory to policy,” Cengage Learning, 2011.
- Karlsson, Ronny**, “Norrmännen sätter historiskt ölkrekord,” July 2018. Accessed 2018-12-29.
- Linden, Ariel**, “Using permutation tests to enhance causal inference in interrupted time series analysis,” *Journal of evaluation in clinical practice*, 2018.
- **and Ann Arbor**, “Conducting interrupted time-series analysis for single-and multiple-group comparisons,” *Stata Journal*, 2015, *15* (2), 480–500.
- Ludwig, David S, Karen E Peterson, and Steven L Gortmaker**, “Relation between consumption of sugar-sweetened drinks and childhood obesity: a prospective, observational analysis,” *The Lancet*, 2001, *357* (9255), 505–508.
- Mao, Z Hu T W &**, “Effects of cigarette tax on cigarette consumption and the Chinese economy,” *Tobacco Control*, 2002, *11* (2), 105–108.
- Ministry of Trade, Industry and Fisheries**, “Business and industry in Norway - The food, beverages and tobacco industry,” 2001. Accessed 2018-12-01.
- Neslin, Scott A and Robert W Shoemaker**, “Using a natural experiment to estimate price elasticity: the 1974 sugar shortage and the ready-to-eat cereal market,” *The Journal of Marketing*, 1983, pp. 44–57.
- Nieburg, Oliver**, “Northern lights out? Chocolate sees big sugar tax hike in Norway,” Jan 2018. Accessed 2018-12-04.
- NTB**, “Vil reversere økningen i sukkeravgiften: – Så ødeleggende,” *abc Nyheter*, Mars 2018. Accessed 2018-12-04.

- Penfold, Robert B and Fang Zhang**, “Use of interrupted time series analysis in evaluating health care quality improvements,” *Academic pediatrics*, 2013, *13* (6), S38–S44.
- Pigou, Arthur**, *The economics of welfare*, Routledge, 2017.
- Powell, Lisa M, Roy Wada, Joseph J Persky, and Frank J Chaloupka**, “Employment impact of sugar-sweetened beverage taxes,” *American journal of public health*, 2014, *104* (4), 672–677.
- Rosen, Harvey S**, “Public finance,” in “The encyclopedia of public choice,” Springer, 2004, chapter 6, pp. 90–105.
- Saeravgiftsseksjonen, Skattedirektoratet**, “Avgift på sukker MV,” 2018. Accessed 2018-11-17.
- The Norwegian Directorate of Integration and Diversity**, “Dismissal,” Jan 2019. Accessed 2019-01-18.
- Thow, Anne Marie, Shauna Downs, and Stephen Jan**, “A systematic review of the effectiveness of food taxes and subsidies to improve diets: understanding the recent evidence,” *Nutrition reviews*, 2014, *72* (9), 551–565.
- Tisdall, Jonathan**, ““Chocolate tax” should go,” *Aftenposten*, Jun 2007. Accessed 2018-12-04.
- Tragakes, Ellie**, *Economics for the IB Diploma with CD-ROM*, Cambridge University Press, 2011.
- Verbeek, Marno**, *A guide to modern econometrics*, John Wiley & Sons, 2008.
- Wada, Roy, Frank J. Chaloupka, Lisa M. Powell, and David H. Jernigan**, “Employment impacts of alcohol taxes,” *Preventive Medicine*, 2017, *105*, S50 – S55. Supplement: Noncommunicable Disease Risk Factors in Developing Countries: Policy Perspectives.
- Wagner, Anita K, Stephen B Soumerai, Fang Zhang, and Dennis Ross-Degnan**, “Segmented regression analysis of interrupted time series studies in medication use research,” *Journal of clinical pharmacy and therapeutics*, 2002, *27* (4), 299–309.
- Wang, Joanna JJ, W Scott, G Raphael, and O Jake**, “A comparison of statistical methods in interrupted time series analysis to estimate an intervention effect,” in “Australasian Road Safety Research, Policing and Education Conference” 2013.

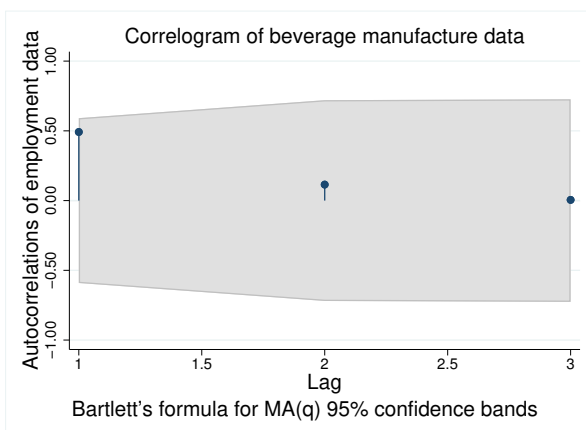
World Health Organization, “Taxes on sugary drinks: Why do it?,” *Department of Prevention of Non-communicable Diseases*, 2017.

Wright, Alexandra, Katherine E Smith, and Mark Hellowell, “Policy lessons from health taxes: a systematic review of empirical studies,” *BMC public health*, 2017, 17 (1), 583.

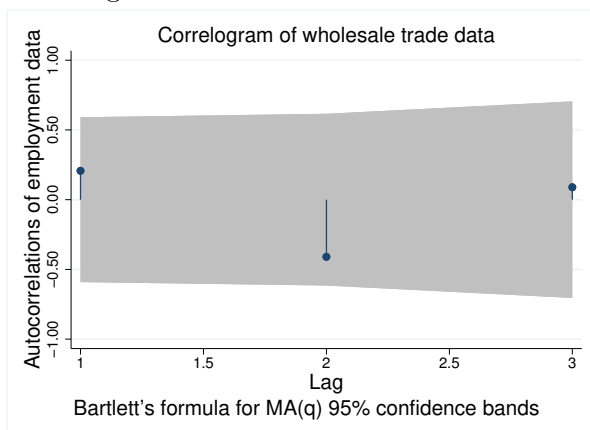
A Correlograms



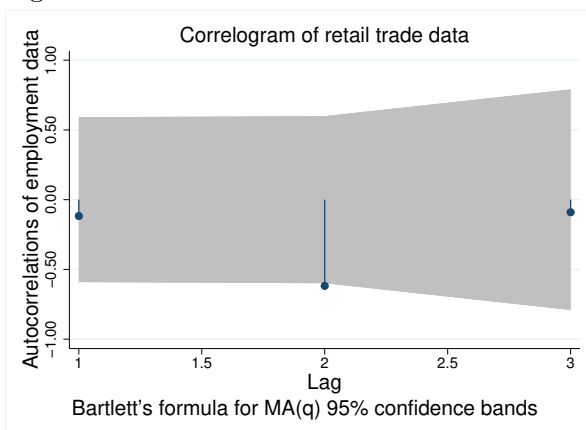
(a) Correlogram showing autocorrelation of data on employment in food products manufacturing.



(b) Correlogram showing autocorrelation of data on employment in beverages manufacturing.



(c) Correlogram showing autocorrelation of data on employment in wholesale trade (excluding motor vehicles and motorcycles).



(d) Correlogram showing autocorrelation of data on employment in retail trade (excluding motor vehicles and motorcycles).

Figure 8: Correlograms showing lag in data for different employment sectors in Norway since January 2016.

Source: author's estimations done using data from Statistics Norway. All the correlograms were constructed using *ac* command in Stata 13.

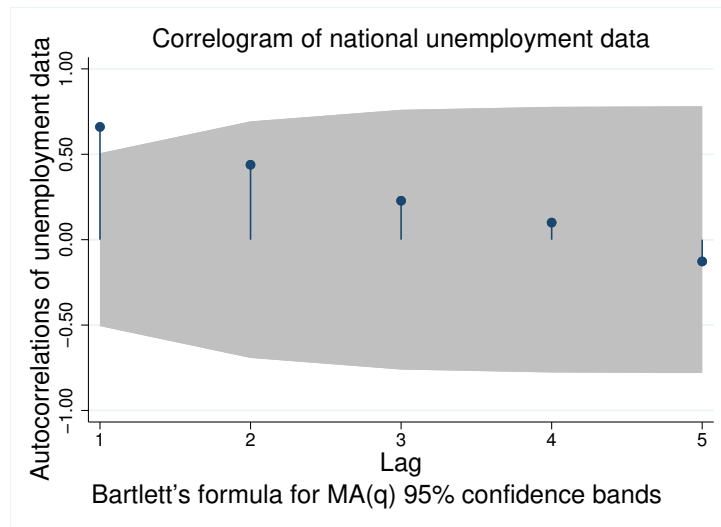
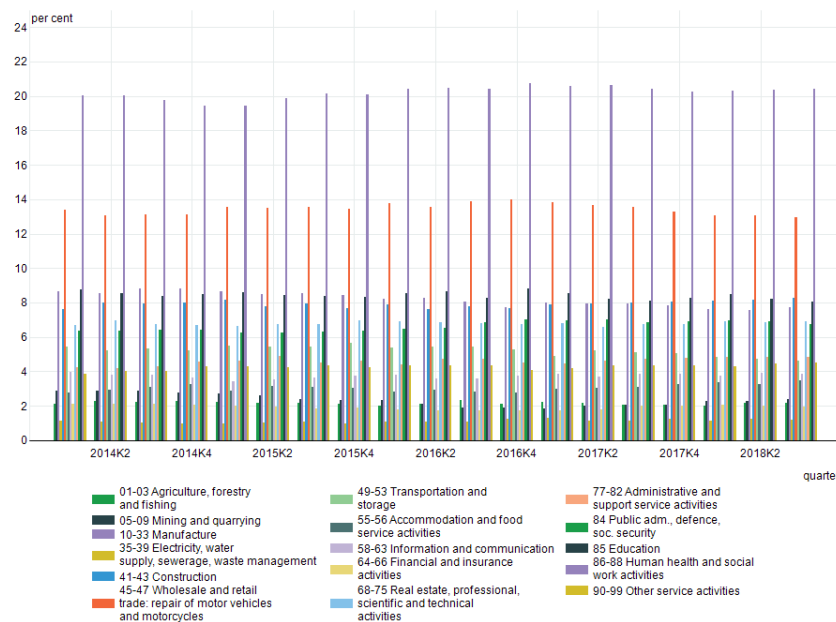


Figure 9: Correlogram showing lag in data for national unemployment in Norway since January 2015.

Source: author's estimations done using data from Statistics Norway. The graph was constructed using *ac* command in Stata 13.

B Labour employment by sector

07972: Employed persons (LFS) (1 000 persons), by industry (SIC2007) and quarter. Both sexes, 15-74 years, Employed persons.



Source: Statistics Norway

Figure 10: A staple diagram showing the statistics on labour force in Norway by sector between January 2014 and October 2018.

Source: data from Statistics Norway.

C Robustness test

Table 6: Robustness test of the ITSA conducted on increased sugar tax in Norway in January 2018.

	Pseudo-intervention a year before (1)		Quadratic specification (3)		Cubic specification (4)	
employment in food sector	coefficient 95% CI	p-value	coefficient 95% CI	p-value	coefficient 95% CI	p-value
intercept β_0	46191.21 (45763.5;46618.91)	0.000	45965.75 (45577.29 46354.21)	0.000	46106.58 (45984.08;46229.08)	0.000
pre-tax trend β_1	-48.91176 (-217.1706;119.3471)	0.465	-104.35 (-339.8116;131.1116)	0.253	-678.5167 (-1151.138;-205.8951)	0.025
intercept change β_2	384.0882 (-94.29247;862.4689)	0.090	-287.1 (-803.7848;229.5848)	0.175	362.9 (-206.0415;931.8415)	0.111
post-tax trend change β_3	129.2059 (-58.36316;316.7749)	0.128	-383.8 (-719.8159;-47.78414)	0.036	461.2 (-223.1509;1145.551)	0.101
post-tax trend $\beta_1 + \beta_3$	80.2941 (1.6479;158.9404)	0.0471	-488.1500 (-1.02e+03;40.0738)	0.0605	-217.3167 (-489.7964;55.1630)	0.0754
employment in beverages sector	coefficient 95% CI	p-value	coefficient 95% CI	p-value	coefficient 95% CI	p-value
intercept β_0	3469.574 (3362.459;3576.688)	0.000	3481.375 (3409.88;3552.87)	0.000	3498.528 (3446.837;3550.219)	0.000
pre-tax trend β_1	-15.89706 (-65.77533;33.98121)	0.426	-7.675 (-41.00274;25.65274)	0.517	-77.60556 (-224.6326;69.42151)	0.151
intercept change β_2	-27.14706 (-147.9948;93.70071)	0.567	-1.3 (-90.11427;87.51427)	0.966	77.86667 (-110.3698;266.1031)	0.217
post-tax trend change β_3	1.323529 (-56.38335;59.03041)	0.952	73.35 (16.91287;129.7871)	0.026	176.2667 (-31.96142;384.4948)	0.068
post-tax trend $\beta_1 + \beta_3$	-14.5735 (-31.5506;2.4035)	0.0757	65.6750 (-16.3662;147.7162)	0.0841	98.6611 (27.2176;170.1047)	0.0272
employment in wholesale trade	coefficient 95% CI	p-value	coefficient 95% CI	p-value	coefficient 95% CI	p-value
intercept β_0	102493.4 (100993.9;103992.8)	0.000	101233.5 (99705.47;102761.5)	0.000	101438.7 (99094.18;103783.3)	0.000
pre-tax trend β_1	-368.2377 (-858.5433;122.0678)	0.105	-328.8 (-1083.194;425.5937)	0.260	-1165.513 (-7250.851;4919.825)	0.497
intercept change β_2	1900.804 (468.7168;3332.891)	0.021	-1737.133 (-3628.507;154.2406)	0.061	-789.9111 (-8076.23;6496.408)	0.687
post-tax trend change β_3	458.2647 (-79.96029;996.4897)	0.077	-887.9 (99705.47102761.5)	0.087	343.4889 (-7990.282;8677.26)	0.876
post-tax trend $\beta_1 + \beta_3$	90.0270 (-107.8944;287.9483)	0.2752	-1.22e+03 (-2.92e+03;484.3680)	0.1073	-822.0241 (-3.71e+03;2061.3926)	0.3448
employment in retail trade sector	coefficient 95% CI	p-value	coefficient 95% CI	p-value	coefficient 95% CI	p-value
intercept β_0	198780.2 (197896.6;199663.8)	0.000	199315.3 (198718;199912.5)	0.000	199696.2 (197684;201708.4)	0.000
pre-tax trend β_1	390.6471 (3.797414;777.4967)	0.049	629.05 (152.8427;1105.257)	0.025	-924.1444 (-6222.955;4374.666)	0.531
intercept change β_2	-931.8529 (-1926.894;63.18789)	0.060	878.3 (-647.562;2404.163)	0.164	2636.633 (-3916.417;9189.683)	0.226
post-tax trend change β_3	-588.3235 (-959.9593;-216.6878)	0.012	728.9 (-280.9254;1738.725)	0.105	3014.733 (-4321.146;10350.61)	0.219
post-tax trend $\beta_1 + \beta_3$	-197.6765 (-332.9800;-62.3729)	0.0154	1357.9500 (105.7936;2610.1064)	0.0409	2090.5889 (-394.9382;4576.1159)	0.0686
national unemployment	coefficient 95% CI	p-value	coefficient 95% CI	p-value	coefficient 95% CI	p-value
intercept β_0	59.85913 (-58.36316;316.7749)	0.460	113.5168 (105.9432;21.0904)	0.000	109.4237 (100.1303;118.7171)	0.000
pre-tax trend β_1	-0.7013831 (-4.930572;3.527806)	0.699	4.650458 (-3.46056;12.76148)	0.201	29.62251 (5.470709;53.77431)	0.027
intercept change β_2	-4.854552 (-26.1879;16.47879)	0.598	3.037158 (-10.28256;16.35688)	0.583	-11.25944 (-21.51134;-1.007542)	0.038
post-tax trend change β_3	0.1039076 (-9.617837;9.825652)	0.980	11.64791 (1.045859;22.24996)	0.037	-6.664538 (-22.81662;9.487541)	0.316
post-tax trend $\beta_1 + \beta_3$	-0.5975 (-6.2677;5.0728)	0.8052	19.1028 (3.9466;34.2591)	0.0205	15.4168 (0.6439;30.1898)	0.0433

Source: author's estimations done using data from Statistics Norway. Robustness models were adjusted for seasonality and two-year lag of dependent variable. The pseudo-intervention sets January 2017 as a pseudo-treatment period. ITSA robustness specifications differ from Equation (1) by having quadratic respective quadratic and cubic time trends included as controls.